December 1967

Brief 67-10659

NASA TECH BRIEF

Buckling Strength of Filament-Wound Cylinders Under Axial Compression Is Investigated

Experimental data have been previously obtained on buckling of filament-wound cylinders having diameter-to-wall thickness ratios ranging from 25 to 304. A reasonable comparison was, in general, achieved between predictions by small deflection orthotropic shell theory and test data. Additionally, it has been noted that a coupling occurs between shear failure and buckling when resin stresses are high enough at the buckling load to cause plastic flow in the resin.

A more recent experimental and analytical study has involved the effects of axial compression on eleven filament-wound cylinders having diameter-to-wall thickness ratios of 167 to 643, the wall structures consisting of three composite layers. One layer is a polar wrap consisting of two half layers at angles offset with respect to the longitudinal axis of the cylinder, and is enclosed by an inner and an outer circumferential wrap. Each of the three layers is of the same nominal thickness. This combination is efficient in the presence of internal pressure and minimizes the effects of initial imperfections on buckling strength by providing circumferential in-plane and bending stiffening. Also, cylinders whose middle layers are not oriented axially produce an anisotropic coupling between stretching and shear.

Analytical predictions for buckling loads were obtained by using linear anisotropic shell theory. The results of the compression tests indicated that the cylinders buckled at 65% to 85% of the loads predicted by classical linear analysis. The buckling mode was coupled with catastrophic shear failure in the smaller cylinders, while the larger cylinders buckled into the classical diamond-shaped pattern with the basic integrity of the cylinder maintained.

The composite moduli required for the buckling analysis were determined for each cylinder from experimental test data obtained by the classical method of using three tests: torsion, internal pressure, and axial tension or compression. It was demonstrated analytically that the anisotropic coupling between stretching and shear only influences the determination of the moduli by terms of the order of the square of the ratio of the thickness of the cylinder to the radius of the cylinder. Thus, because of the thinness of the cylinder walls, the anisotropic coupling was found to have a negligible effect on the experimental determination of the moduli.

Note:

Further information concerning this invention is presented in NASA CR-266, "The Buckling Strength of Filament-Wound Cylinders Under Axial Compression" by J. Tasi, A. Feldman, and D. A. Stang, July 1965, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price $3.00. Inquiries may also be directed to:

Technology Utilization Officer
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Reference: B67-10659

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: HQN-10032

Category 03